

When we have come to the conclusion that there is going to be no further increase in the muscle power and that the picture is stationary, we have reached the stage where reconstructive surgery may be undertaken. This is known as the chronic stage and is usually considered to have been reached two years after the onset. Previous to this the only surgery undertaken has been to remove deformity which interferes with treatment. No matter how good preliminary treatment has been or how efficient our supervision there are always going to be a certain number of cases that will be benefited by constructive surgery. These surgical procedures may be grouped into those in which the tendons, fascia and ligaments are used, and those in which the work is mainly carried out on the bony structures. In children the operations, as a rule, fall into the first class because we wish to disturb the growing bone as little as possible. The operations in this class are usually tendon transplants and the fasciotomies. As the patients become teenagers and adults we find the operations on the bony structures are the more usual procedures. None of these reconstructive operations should be undertaken without having the case carefully worked out and without having a clear conception of the actual technique of the surgical procedure contemplated. For example in the subastragaloid arthrodesis one of the most important things to remember is that besides doing the bone work one must dislocate the foot backwards. At the same time that these bone operations are done we should not forget that the pull of a tendon, even so very slight, can ruin a well performed bone job. If the pull of the tendon is likely to cause recurrence of deformity the tendon must be transplanted.

In this series of 1,032 cases, 325 operations were performed. As some of these patients were operated upon several times it must be seen that the majority of the cases made a good recovery or only had a minimal amount of disability. Using the classification given in the last paragraph 109 of these operations were in the tendon and fascial class and 216 in the bone class. Many of the 216 operations might be described as primary operations but a great many had to be done on account of failure of the tendon or fascial procedures which were carried out when the patients were younger.

The experience obtained seems to show that the after care of poliomyelitis can be safely carried out under the fundamentals laid down by Jones and Lovett. They are not very many nor are they hard to remember. In the first stage the treatment is set out under three headings: rest, prevention of deformity, and the avoidance of meddlesome therapeutics. In the second or convalescent stage attention is given to physiotherapy, and surgery is only used to remove a deformity which interferes with the treatment. The third or chronic stage is the only one in which reconstructive surgery should be attempted.

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RÉSUMÉ

L'auteur donne une brève définition de la poliomyélite et la variété des symptômes par lesquels cette maladie se manifeste. Il semble évident que la prédominance d'un symptôme en particulier varie avec les différentes épidémies. Le traitement est divisé en plusieurs parties.

Au début: 1°. Le repos pour soulager la douleur, avec comme adjuvant les enveloppements humides préconisés par Sister Kenny. 2°. La prévention des difformités; l'auteur indique les différents moyens et la conduite à tenir dans leur application.

Dans la période de convalescence: 1°. La physiothérapie sous la direction de physiothérapeutes entraînés. Par cette méthode les muscles atteints sont rééduqués. 2°. Le traitement chirurgical lorsque le progrès est devenu stationnaire et la maladie rendue chronique i.e. deux ans après son début. Ce traitement comprend la chirurgie des tendons, ligaments, aponévroses et la chirurgie osseuse. La première est employée surtout chez les enfants dans la période de croissance.

YVES PRÉVOST

THE SUPERFICIAL ULNAR ARTERY WITH REFERENCE TO ACCIDENTAL INTRA-ARTERIAL INJECTION

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THE discovery of a superficial ulnar artery during surface anatomy classes at the University of Toronto and the availability of specimens for further investigation have served to inspire this article. Certain anatomical variations of the brachial artery and its branches at the elbow have been recorded for many years. However it is only recently, with the frequent use of intravenous injections, that this significance has been disastrously demonstrated.

Normal arteries of the elbow and forearm.—The brachial artery begins at the lateral limit of the axilla and ends less than an inch below the bend of the elbow by dividing into the radial and ulnar arteries. In the

arm the artery at first lies medial to the humerus and then it gradually moves laterally on the brachialis until at the elbow it lies midway between the two epicondyles of the humerus. It is subfascial throughout its course, being covered by skin, superficial fascia and deep fascia. At the elbow it sinks deeply into the cubital fossa and is there covered by the bicipital aponeurosis of the biceps tendon.

The larger ulnar and the smaller radial artery arise in this fossa and pass obliquely down the ulnar and radial sides of the forearm to the wrist and beyond. As the ulnar artery courses deep to the superficial flexors of the forearm and flexor digitorum sublimis, it gives off a large common interosseous branch and two recurrent branches. The radial artery is crossed by no muscle in the forearm, but it is overlapped by the brachioradialis in its upper two-thirds.

Anomalous superficial arteries in the forearm.

—The blood vessels of the body are noted for their frequent variations from their normal courses. These variations can best be appreciated when the method of development of blood vessels is recalled. The arteries of the body are not laid down as the individual tubular structures known to us from the study of adult anatomy. A more alterable process takes place with remarkable variations possible. Thus, the developing limb buds of the embryo are provided with networks of capillaries which advance and expand into the growing limb, until about the sixth fetal week, certain channels through this maze of vessels are selected to become the main artery. The remainder of the network becomes side branches or completely disappears. Although the channel selected is surprisingly consistent, persistence of other parts of the network as the main vessel results in variations of the course and distribution of the artery.

The brachial artery may suffer from this process of variation. For example, with considerable frequency the brachial artery divides at a higher level than usual. In this case the radial artery most commonly arises high up as a single branch, leaving the ulnar artery to follow its usual course and distribution. Less commonly the ulnar artery arises high up as a single branch, leaving the radial artery to give rise to the common interosseous artery and follow its usual course. In either case a superficial artery may result in the forearm. Such an artery courses down the forearm superficial to muscles and subjacent to deep fascia which is here quite thin. Occasionally, however, it may course superficial to the deep fascia for a variable distance on the forearm.

In 1844, Richard Quain, the professor of anatomy at University College, London, pub-

lished his observations on the arteries of 1,040 bodies. This culmination of long labour is today our classical reference to the arteries and their variations. From his tabulated observations I have culled statistical data on superficial arteries. He found high division of the brachial artery, usually near its origin, in 12% of 418 limbs. The radial artery had a high origin in 11% of 429 limbs and the ulnar artery in 7.3% of 422 limbs. In almost every instance in which the ulnar artery arose high, its course was superficial; that is to say, an ulnar artery with high origin will almost always be a superficial ulnar artery. Additional statistics on the superficial ulnar artery, gathered from Quain's observations, are given in Table I.

TABLE I.
(AFTER QUAIN 1844)

Detail	Right arm	Left arm	Total
No. of limbs examined.....	225	197	422
High origin of ulnar artery. . .	19	12	31
Superficial ulnar artery. . . .	18	11	29
(a) Unilateral.....			13
(b) Bilateral.....			8
(c) Deep to deep fascia throughout.....	14	10	24
(d) Deep to deep fascia and palmaris longus only.....	1	1	2
(e) Superficial to deep fascia.....	2	0	2
(f) Superficial to deep fascia and then deep	1	0	1

Incidence of superficial ulnar artery 6.8% of 422 limbs.

Adachi, in his work on Japanese cadavers in 1928 at Kyoto and Okayama, found 0.7% superficial ulnar arteries in 1,198 limbs. He also summarizes the work of European observers which showed an incidence of 2.5% of 488 limbs. This difference causes Adachi to observe, rightly or wrongly, that the Japanese are further advanced along the evolutionary scale than members of the Caucasian race.

ORIGINAL RESULTS

(a) *In cadavers.*—In the Department of Anatomy of the University of Toronto, 6 superficial ulnar arteries were found in 188 dissected limbs that were examined, an incidence of 3.1% of limbs. All but one of these six superficial arteries had a high origin; the sixth originating below the level of the medial epicondyle and then rapidly becoming superficial. In two cases the artery coursed between skin and deep fascia for a variable distance below the elbow, then pierced the fascia, and ran deep to it. The

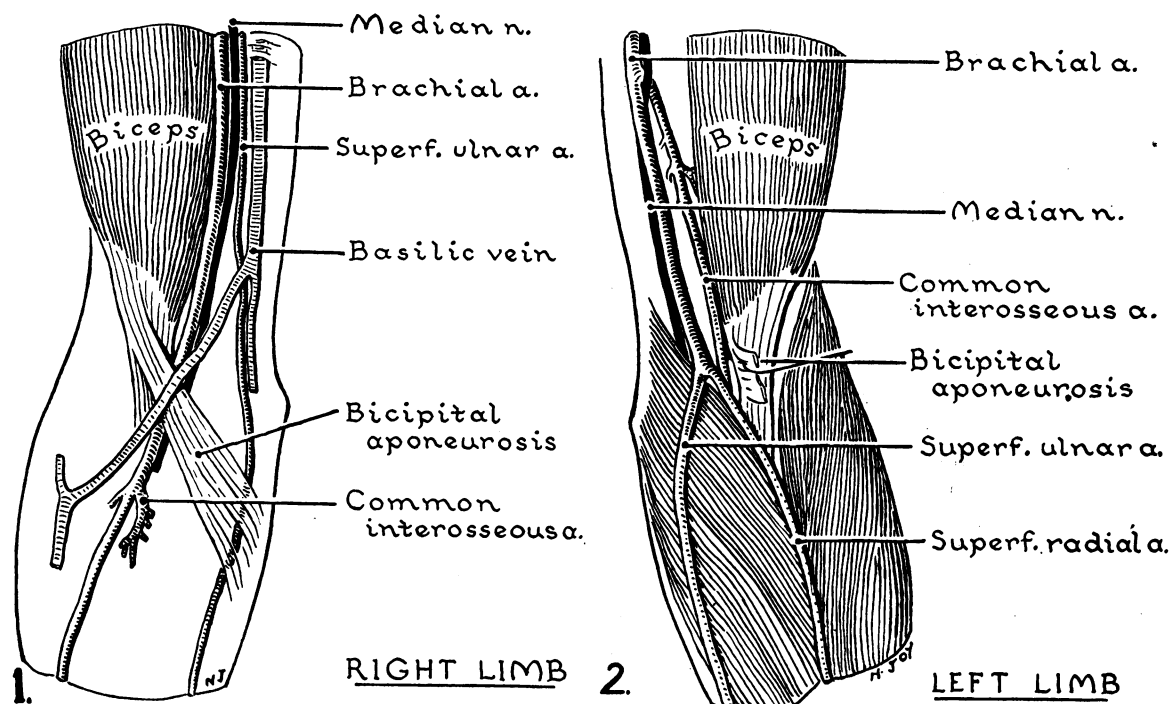


Fig. 1.—A superficial ulnar artery, which arose high in the arm, is coursing through the bicipital aponeurosis superficial to the muscles of the forearm (not shown) and is closely accompanied by a tributary of the basilic vein. Fig. 2.—A superficial ulnar artery and a superficial radial artery are arising from the brachial artery by a common stem and passing deep to the bicipital aponeurosis (reflected) but superficial to the muscles of the forearm.

remaining four arteries were subjacent to deep fascia throughout the forearm. Of these four arteries, one was in addition deep to palmaris longus. In all six cases the interosseous artery and consequently the main blood supply of the forearm was derived from the radial division of the brachial artery (see Figs. 1 and 2). The

superficial ulnar artery was however, always of good size and contributed to the superficial palmar arch in the palm of the hand. Further observations are tabulated in Table II.

(b) *In medical and dental students.*—In order that the incidence of the abnormality under discussion might be related in cadaver and living subject a survey was made of superficial ulnar arteries discernable by inspection and palpation of the forearm. For this purpose a group of 271 medical and dental students were

TABLE II.
CADAVERS
ANATOMY DEPARTMENT, UNIVERSITY OF TORONTO,
1945-1948

Detail	Right arm	Left arm	Total
No. of limbs examined.....	94	94	188
(a) Male.....			184
(b) Female.....			4
High origin ulnar artery			
(a) Axilla.....	1	2	3
(b) Midarm.....	2	0	2
(c) 1½" below med. epicondyle.....	1	0	1
Superficial ulnar artery....	4	2	6
(a) Unilateral.....			4
(b) Bilateral.....			1
(c) Deep to deep fascia throughout forearm	2	1	3
(d) Deep to deep fascia and palmaris longus.	0	1	1
(e) Superficial to deep fascia.....	0	0	0
(f) Superficial to deep fascia and then deep	2	0	2

Incidence of superficial ulnar artery 3.1% of 188 limbs or 5.3% of 94 cadavers.

TABLE III.
LIVING SUBJECTS
MEDICAL AND DENTAL STUDENTS
UNIVERSITY OF TORONTO, 1949

Detail	Right arm	Left arm	Total
No. of limbs examined.....	271	271	542
(a) Male.....			514
(b) Female.....			28
Superficial ulnar artery....	7	8	15
(a) Unilateral.....			9
(b) Bilateral.....			3
(c) Distance palpable on forearm			
1. One to two inches.	2	3	5
2. Two and half to three inches....	3	3	6
3. Three and half to five inches.....	2	2	4

Incidence of superficial ulnar artery 2.7% of 542 limbs or 4.4% of 271 living subjects.

examined. The examination consisted of inspecting and palpating the medial side of the arm and forearm as though an intravenous injection were contemplated. That is to say, the subject's limb was examined in a good light with the forearm supported and relaxed and the elbow flexed.

A superficial ulnar artery was discovered in 15 instances, an incidence of 2.7% of the 542 limbs examined and almost identical with the results found in the cadavers. There were three bilateral and nine unilateral cases. Fourteen women were included in this group and a superficial artery was not found among them.

The anomalous artery was usually quite easily discovered outlined on the skin surface just below the medial half of the skin crease in front

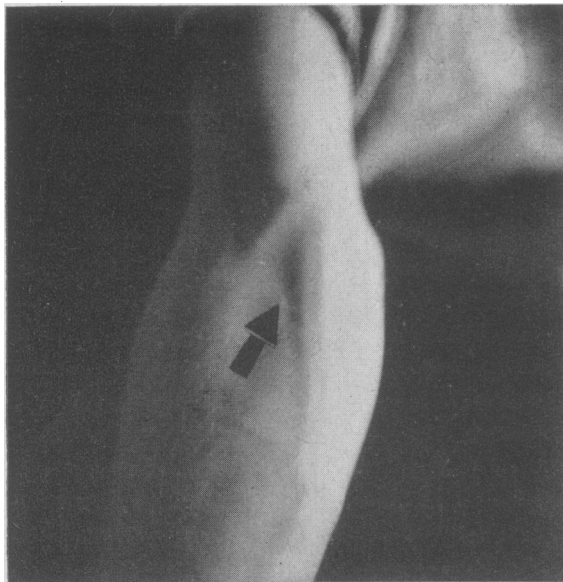


Fig. 3.—The arrow points to a superficial ulnar artery closely accompanied medially by a superficial vein. This artery is easily seen and palpated for five inches in the forearm.

of the elbow. It is noteworthy that a well marked superficial vein always accompanied the artery closely on one side or other as a companion vein (Fig. 3). The artery lacked the bluish colour of the superficial veins. Pulsation was discernible on inspection in only four cases, but on palpation it was always felt with little difficulty. A tourniquet applied to the arm obliterated pulsation in the superficial vessel.

In addition to these observations, it was noted that the brachial artery was quite superficial and easily palpated at the bend of the elbow joint, just medial to the biceps tendon, in a considerable number of cases. All the arteries noted as superficial ulnar arteries, in addition

to these easily palpable brachial arteries, must be considered in danger if an intravenous injection was contemplated.

ACCIDENTAL INTRA-ARTERIAL INJECTION

Gangrene of the fingers or of the forearm and muscle contracture have followed injection of arteries with iodides for pyelograms or arteriograms, ethanolamine for varicose veins, quinine for malaria, arsphenamine or bismuth for syphilis and sodium pentothal for induction anaesthesia. Lundy states that even death may occur following an intra-arterial injection of pentothal because the drug does not suddenly mix with a large volume of blood in the heart and reach the brain; hence warning signs do not occur as in intravenous injection. Anaesthesia which usually follows intravenous injection in 5 to 10 seconds will not occur for 45 to 50 seconds when given intra-arterially, consequently an overdose of pentothal may be given.

Reported cases are rare, naturally, and are usually due to the use of sodium pentothal in a 5 or 10% solution. Cohen of Gravesend, England, recently reported 12 cases. In these, the injection was made into a superficial ulnar artery in at least 5 cases and into the brachial artery in 5 cases. Eight of the patients eventually had amputation of either the forearm or fingers; whereas four had their limbs recover, one with contraction and one with atrophy of the forearm.

The essential pathology of intra-arterial damage includes early or late thrombosis of the artery coupled with distal arteriolar spasm. Since the anaesthetic or other agent is only momentarily held in the artery, the resultant damage must be due to immediate and severe irritation; in the case of pentothal it is possibly due to the high pH of the solution. The symptoms of injection are first a burning, fire-like pain in the hand followed by blanching of the hand, cyanotic fingers and bluish mottling of the forearm occasionally accompanied by oedema. Delayed loss of consciousness up to one minute may be the only sign immediately after injection.

Treatment, once the condition is recognized, should include immediate or postoperative heparinization, possibly with an injection into the affected artery. If the operation in progress must proceed, cyclopropane anaesthesia, due to its effect on the clotting mechanism, is

best advised. Sympathetic ganglion or brachial plexus novocaine block is valuable as in other cases of arterial thrombosis. Surgical intervention for the arterial thrombosis should take place, if at all, within a few hours after the accident and consist of arteriotomy with clot extraction. Subsequent therapy should consist of keeping the affected limb wrapped up at room temperature, immersing the opposite upper limb in hot water, covering the body with a heat cradle and the use of vasodilators such as tetraethyl ammonium chloride or papaverine hydrochloride.

Preventive measures of value include knowledge of the arterial abnormalities at the front of the elbow, careful palpation of the forearm with and without a tourniquet in a good light, awareness of the possibility of such an accident and immediate diagnosis followed by proper treatment. If these measures are practised by those concerned in the increasing use of intravenous drugs, the occurrence of intra-arterial injection and its sequelæ will decrease.

SUMMARY

1. The anatomy of the arteries at the front of the elbow is given and possible abnormalities are noted.

2. Observations regarding the superficial ulnar artery were made on 94 cadavers and 271 university students. It was found to arise high in the arm, to supply only a few twigs to the muscles of the forearm and to terminate with normal ulnar distribution in the hand. It was easily found for a distance of one to five inches on the forearm of the living subject, always closely accompanied by a superficial vein. It was bilateral in 4 of 17 individuals and occurred in 2.9% of 730 limbs.

3. The problem of accidental intra-arterial injection is reviewed. Pathology, symptoms and treatment are presented.

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THE TREATMENT OF ESSENTIAL HYPERTENSION*

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BECAUSE of the conflicting reports, particularly of more recent methods in the therapy of high blood pressure, this very important subject is at present in a state of confusion in the mind of the average practitioner. In the light of our present knowledge, an attempt will be made to outline the proper course of action to be taken when confronted with a case of hypertension, particular emphasis being placed on the therapy of essential hypertension.

DIAGNOSIS

Diagnosis is of primary importance in order to rule out the non-essential types of high blood pressure. For this purpose, hypertension is best divided into the two great groups: (1) systolic and (2) diastolic.

1. *Systolic hypertension*.—First just a word about the systolic hypertensions, where only the systolic pressure is raised and which is the common hypertension seen in the elderly due to an atheromatous aorta (where no special therapy is required). It is also seen in aortic regurgitation, thyrotoxicosis and complete heart block, where one attempts to treat the original condition: or it may be a sign of patent ductus arteriosus as well as arteriovenous aneurysm where therapy consists of surgical closure of the abnormal shunt.

2. *Diastolic hypertension*.—However, we are more concerned with the diastolic hypertensions where the diastolic blood pressure is 100 or more. From the therapeutic point of view it is helpful when first presented with a case of diastolic hypertension to think of three possibilities:⁹ (a) *Secondary to a known underlying process or disease which cannot as a rule be completely remedied*. Here therapy of course is chiefly that of the underlying condition. Examples of this group are glomerulonephritis, polycystic disease of kidney and Cushing's syndrome. (b) *High blood pressure due to more specific and often remediable causes*. This is the group that responds best to treatment of the

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